REVISION OF TWO UPPER CAMBRIAN TRILOBITES

by A. W. A. RUSHTON

ABSTRACT. *Conocoryphe*? *bucephala* Belt, 1868, from the Upper Ffestiniog and Lower Dolgelly Beds of Wales, and possibly England, is re-illustrated; the pygidium is described for the first time; the species is transferred from the Olenid genus *Beltella* to which it was referred by Lake (1919) to *Parabolinoides* Frederickson, a genus widely known in the approximately contemporaneous *Conaspis* Zone in the U.S.A.

Sphaerophthalmus major Lake, 1913, though regarded by Henningsmoen (1957) as of questionable validity, is distinguishable from other species of *Sphaerophthalmus*; *S. major* occurs in England, Wales, and Sweden, and probably in Norway and eastern Canada, in the Zone of *Peltura scarabaeoides*.

IN his monograph on the Olenidae, Henningsmoen (1957) commented on the two Upper Cambrian trilobite species *Conocoryphe*? *bucephala* Belt and *Sphaerophthalmus major* Lake, but for lack of data was unable to frame a diagnosis for either. In connexion with work on the Cambrian faunas from the Institute of Geological Sciences Merevale No. 1 borehole (Rushton, 1966), I examined the type-material of both these species including material from the following museums: British Museum (Natural History) (BM), Geological Survey Museum (GSM), Oxford University Museum (Ox), and the Sedgwick Museum, Cambridge (SM). The terminology used in the description below is that of Henningsmoen (1957).

Family PARABOLINOIDIDAE Lochman
Genus PARABOLINOIDES Frederickson 1949

Type species (by original designation). *Parabolinoides contractus* Frederickson 1949.

Parabolinoides bucephalus (Belt 1868)

Text-fig. 1; Plate 77, figs. 1–10, 11?

1868 *Conocoryphe*? *bucephala* Belt, p. 10, pl. 2, figs. 1–6.
1873 *Conocoryphe Williamsoni* Salter, p. 12 [Not *Conocoryphe Williamsonii* Belt, 1868].
1919 *Beltella bucephala* (Belt); Lake, p. 106, pl. 12, figs. 11–15.
1919 *Beltella verisimilis* (Salter) [*partim*]; Lake, p. 107, pl. 13, figs. 4, 5 only.
? 1927 *Beltella*? sp. nov. Cobbold, p. 557.
? 1930 *Beltella* cf. *bucephala* (Belt); Stubblefield, p. 57.
1957 *Olenus*? *bucephalus* (Belt 1868); Henningsmoen, p. 111 (with further synonymy).

Lectotype (selected by Henningsmoen 1957, p. 111). The original of Belt's plate 2, fig. 1. The only specimen extant which can be considered as this original is BM I 7578 from the Upper Ffestiniog Beds near Dolgelly, shown here on Plate 77, fig. 7; it is the only relatively large and complete specimen in Belt's collection, is the same size as his figure, and also agrees in being rather obscure in the posterior part of the shield. It is assumed that the figure is restored.

Remarks on the material studied. The specimens of *Conocoryphe*? *bucephala* collected by Belt and now in the British Museum (Natural History) and the Geological Survey

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Museum show the effects of flattening, crushing, and deformation to varying extents: the lectotype is obliquely compressed and the preglabellar field is crushed on to the anterior extension of the doublure of the slightly displaced free cheek; the cranidia in Plate 77, figs. 3 and 4, are laterally and frontally compressed respectively, and that shown in fig. 1 is crushed flat but seems to be relatively undistorted. The glabella of the type specimen of *Conocoryphe williamsoni* Salter *non* Belt (Pl. 77, figs. 10*a* and *b*) is crushed on to the hypostoma, and the preglabellar field on to part of the free cheek, as in the lectotype of *Parabolinoides bucephalus*; the free cheeks are displaced backwards and inwards relative to the cranidium and the pygidium is steeply inclined relative to the thorax, but otherwise the specimen is good, being but little flattened and deformed.

In an attempt to determine the original proportions of *P. bucephalus* the method suggested by Henningsmoen (1960, p. 207) was applied to two mature cranidia on one of Belt's slabs of Upper Ffestiniog Beds (GSM Za 4843) which satisfy the necessary conditions except that one is somewhat larger than the other. The calculation indicates that the original ratio of length to breadth of the cephalic axis was 4:3, which is in good agreement (less than 5 per cent. difference) with the ratios obtained from the apparently undeformed specimens shown in Plate 77, figs. 1, 6, and 10*a*; in contrast, direct measurement of the obviously deformed specimens in figs. 3 and 4 gives ratios of 2·0:1 and 0·9:1 respectively.

Description. Lake's description of the species is mainly correct but it requires some amplification, particularly in the account of the cranidium.

Cephalic axis prominent, tapered, rounded in front, breadth three-quarters of length; S1 weak or distinct, long, oblique backwards, straight or slightly convex; S2 weak, short, less oblique; a few specimens show traces of S3, as stated by Belt (1868, p. 10); the appearance of the glabellar furrows varies much according to the state of preservation. Occipital furrow deepest medially, composite; occipital ring apparently without node or spine. Frontal area one-third to nearly half as long as cephalic axis; border-furrow slightly bowed forwards and, in some specimens, with a weak median in-bend; anterior border crescentic or subtriangular, longer at the mid-line than the preglabellar field. Eye-ridges distinct or weak. Eyes opposite S2 or L2. Inter-ocular cheeks half or less than half as wide as the glabella at the eye-line; post-ocular cheeks rounded postero-laterally, slightly narrower than the occipital ring. Pre-ocular facial sutures straight, divergent forwards to the border-furrow, strongly convergent over anterior border; post-ocular facial sutures divergent, slightly convex.

Free cheek with broad border and long anterior extension of the doublure (Pl. 77, fig. 8). Ventral sutures unknown.

There are twelve thoracic segments in the type-specimen of *Conocoryphe williamsoni* Salter and twelve or thirteen in the lectotype of *C.? bucephala*, in which the joint between the thorax and pygidium is not very clear. The pleural tips are pointed and the axis lacks nodes except in young specimens.

Pygidium poorly known; pygidial axis with about four rings (including terminal); pleural regions with about three pleural and two interpleural grooves, three pairs of marginal spines and a striated doublure (Pl. 77, fig. 10*b*).

Young specimens in Belt's collection have a convex glabella which, compared with adult specimens, is larger in proportion to the rest of the cranidium (Pl. 77, fig. 9).

Measurements in mm.

	SM A3095	BM 59284	BM It 2585
Length of cranidium	11·0	10·0	6·1
Width of cranidium	17·2	16·1 (est.)	9·0
Length of cephalic axis	*c.* 7·6	7·2	4·2
Width of cephalic axis	5·8	5·3	3·2

The lectotype is about 34 mm. long; SM A3095 is about 30 mm. long (restored).

Remarks. I agree with Lake (1919) in regarding Salter's *Conocoryphe williamsoni* as a synonym of Belt's *C.? bucephala.* Compared with *C.? bucephala* the glabella of *C. williamsoni* seems to be slightly smaller in proportion to the rest of the cranidium but this may be because in *C. williamsoni* it is preserved convex (except where crushed on to the hypostoma), whereas in the relatively undeformed specimens of *C.? bucephala* it is 'spread' by flattening and crushing. Otherwise, so far as the species can be compared, they agree quite well. The small cranidium collected by Stubblefield (1930) from Bentleyford Brook in Shropshire is slightly flattened compared with young specimens in Belt's material and has a less prominent anterior border, but is otherwise very similar. The specimens collected by Stubblefield from concretions in Comley Brook, Shropshire (Cobbold 1927, p. 557) and considered by him to be the same species as the Bentleyford cranidium are very small but may provisionally be retained as *Parabolinoides* cf. *bucephalus.*

I have not seen the specimens from the Ffestiniog Beds illustrated by Lake (1919) as belonging to the Tremadoc species *Beltella verisimilis* (Salter), but from the illustrations they appear to be laterally compressed specimens of *Parabolinoides bucephalus.*

Generic position. The chief features of *Conocoryphe? bucephala*—the tapered glabella with oblique furrows and rounded front, wide anterior border, small eyes close to the glabella, the course of the facial suture and the spinose pygidium—are those of *Parabolinoides* Frederickson.

Belt's original reference to *Conocoryphe?* followed Salter's example in using the name for what would now be called ptychoparioid trilobites. Subsequent writers (Reed 1900; Lake 1919; Henningsmoen 1957) agreed in assigning *P. bucephalus* to the Olenidae, but the wide cephalic border and divergent pre-ocular sutures are not typical of that family. Nevertheless, *P. bucephalus* otherwise resembles late *Olenus* species such as *O. cataractes* Salter which, however, has more thoracic segments and stronger glabellar furrows;

EXPLANATION OF PLATE 77

Figs. 1–10. *Parabolinoides bucephalus* (Belt). 1. Cranidium, Ffestiniog Beds near Penmaenpool, Merioneth, ×2½, BM 59284. 2–5. Deformed cranidia, Upper Ffestiniog Beds near Dolgelly (Belt Collection), ×2½: GSM Za4844, BM I 7580, BM I 7588, BM I 7590 respectively. 6. Crushed cranidium with part of thorax; Ffestiniog Beds? ×2½, BM It 2585. 7, 8. Lectotype and free cheek, Upper Ffestiniog Beds near Dolgelly (Belt Collection), ×2½, BM I 7578, BM I 7583. 9. Convex immature cranidium, probably this species, ×5, BM 58499. 10. Complete specimen (type specimen of *Conocoryphe williamsoni* Salter), Lower Dolgelly Beds, Rhiwfelyn SM A3095; 10*a*, ×2½; 10*b*, view of pygidium, ×5. 11. *P.* cf. *bucephalus* (Belt); immature cranidium from Orusia Shales (Lower Dolgelly Beds) in tributary of Bentleyford Brook, Shropshire, ×5, GSM D2655.

Photographs by Mr. C. Friend.

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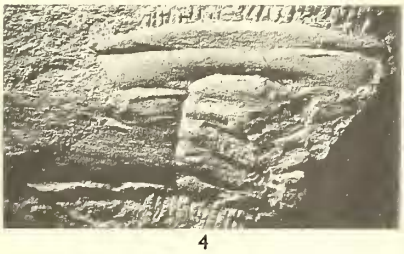

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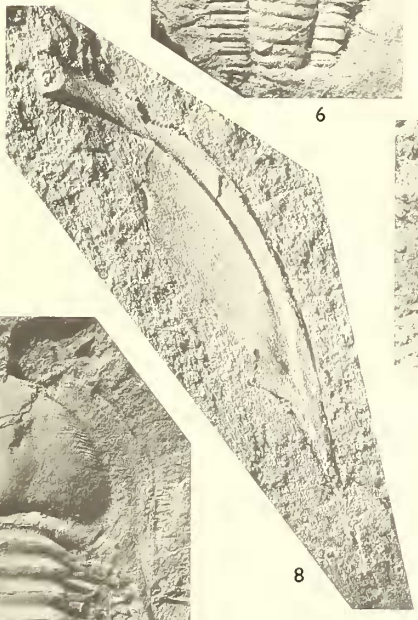

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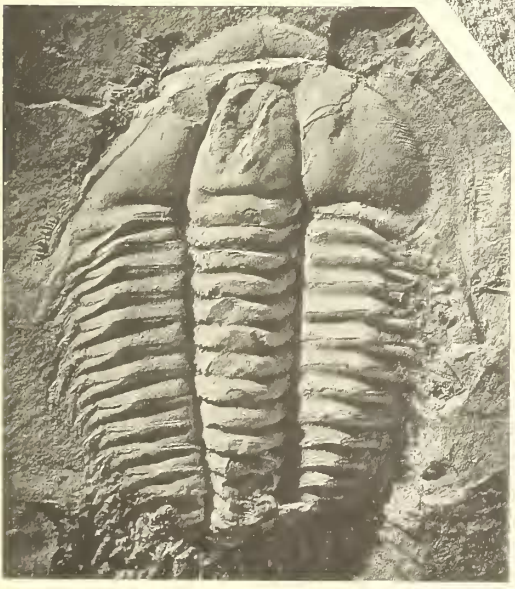

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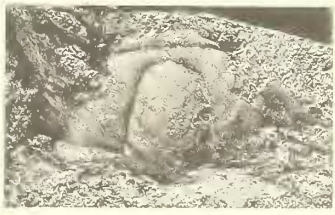

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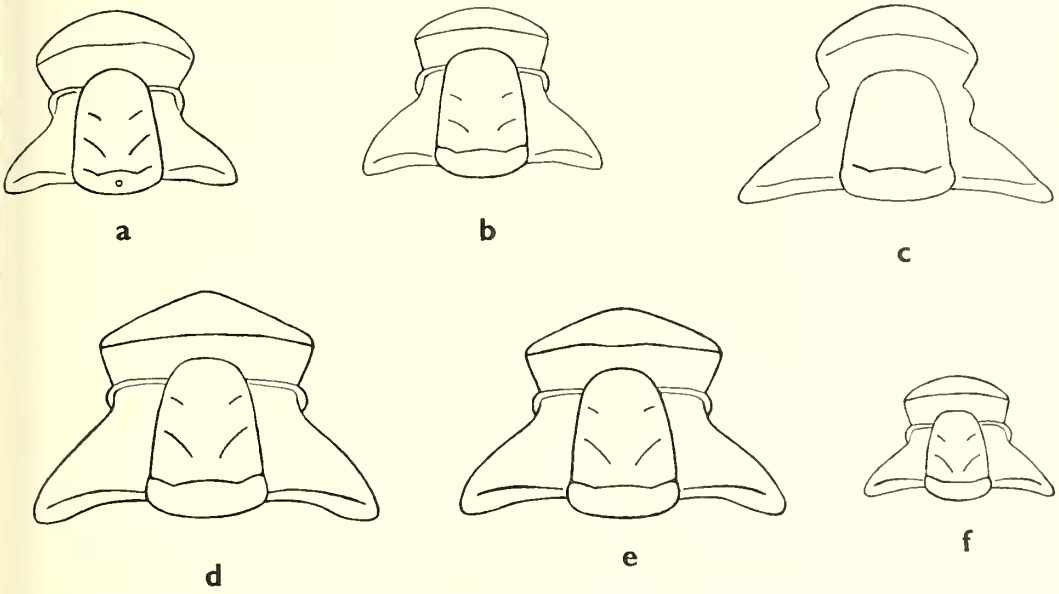
RUSHTON, Upper Cambrian trilobites

species of the (typically Tremadoc) olenid genus *Beltella* Lake differ in having truncate pleural tips and an entire pygidial margin. *Leptoplastides* Raw, which is related to *Beltella* (Henningsmoen 1957, p. 265) but has spinose pleurae, differs from *P. bucephalus* in having axial spines and a different type of free cheek. *Beltella solitaria* Westergård (1922, pl. 14, fig. 1) has a less prominent anterior border and a truncate glabella, and seems to be a true Olenid.



TEXT-FIG. 1. Diagrammatic drawings of cranidia of *Parabolinoides* species, about $\times 2\frac{1}{2}$. (*a*) *P. contractus* Frederickson (after Frederickson 1948). (*b*) *P. hebe* Frederickson (after Frederickson 1948). (*c*) *P. palatus* Berg (after Berg 1953). (*d–f*) *P. bucephalus* (Belt), restored from various specimens.

P. bucephalus is placed in *Parabolinoides* rather than any other genus of the Parabolinoididae such as *Maustonia* Raasch *in* Lochman or *Taenicephalus* Ulrich and Resser *in* Walcott because the post-ocular sutures are convex rather than sinuous (see Lochman *in* Harrington *et al.* 1959, p. O272). *Bernia* Frederickson which has convex post-ocular sutures is considered a synonym of *Parabolinoides* by Bell and Ellinwood (1962, p. 398).

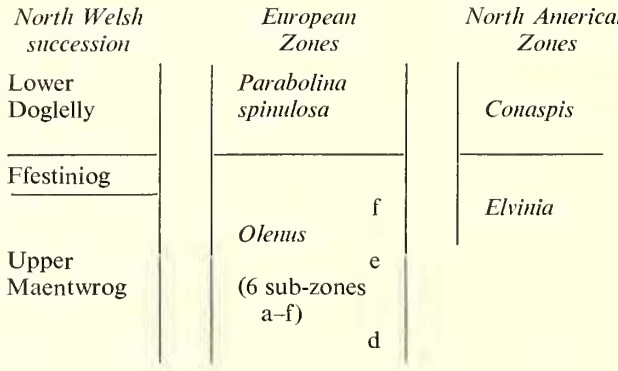
Comparison with other species (text-fig. 1). *Parabolinoides bucephalus* differs from other species of *Parabolinoides* in having the inter-ocular cheeks about half as wide as the glabella, whereas in other species they are only about one-third as wide. The most similar species are *P. contractus* Frederickson (1949) which, however, also differs in having a longer frontal area and an occipital node, and *P. hebe* Frederickson which has a relatively short anterior border and a more truncate glabella. *P. palatus* Berg (1953) has a relatively short, square glabella and more transverse post-ocular sutures. *P.? cordillerensis* Lochman (1950) has relatively very narrow inter-ocular cheeks and somewhat sinuous post-ocular sutures.

Occurrence. Parabolinoides bucephalus has been found in North Wales and possibly in Shropshire at horizons at or near the top of the *Olenus* Zone and in the *Parabolina spinulosa* Zone (Upper Ffestiniog and Lower Dolgelly Beds).

The specimens in Belt's collection are all labelled 'Upper Ffestiniog, Dolgelly' and in his account of the species Belt (1868) mentions the localities Gwern-y-barcud (near Penmaenpool), Mynydd Gader, and near Craig-y-Dinas. G. J. Williams collected *P. bucephalus* at the same horizon in Nant Cistfaen and on Trinant, near Arenig (Lake 1919, pp. 107, 109). Mr. S. W. Hester of the Geological Survey has collected a specimen identified by Stubblefield as *Beltella* cf. *bucephala* from the basal Lower Dolgelly Beds at Ogof Ddu, one mile east of Criccieth, Caernarvonshire. The type of *Conocoryphe williamsoni* Salter is stated by Lake (op. cit., p. 107) to be from the 'Upper Lingula Flags' (= Dolgelly Beds) at Rhiwfelyn in the Upper Mawddach Valley; a variety of horizons is exposed near Rhiwfelyn (Wells 1925, map, pl. 32) but the lithology of the specimen agrees with that of the Lower Dolgelly Beds which yield *Parabolina spinulosa* (Wahlenberg).

Immature cranidia of *Parabolinoides* cf. *bucephalus* have been collected from a septarian nodule from Comley Brook, south Shropshire (Cobbold 1927, pp. 556–7) where they were associated with *Parabolina spinulosa* and *Orusia lenticularis* (Wahlenberg). In a section at Bentleyford Brook a single immature cranidium was collected near the base of a 63-ft. thickness of micaceous shales which, at higher horizons, yielded also *Orusia lenticularis* and *Parabolinites*? [*Parabolinella*] aff. *williamsonii* (Belt).

Apart from *P. bucephalus*, recorded species of *Parabolinoides* are confined to the *Conaspis* Zone in the central parts of the United States of America (Lochman and Wilson 1958, see text-figs. 9, 10, 11). If, as has been suggested, the top of the *Elvinia* Zone is not higher than the top of the *Olenus* Zone (Rushton 1967), *P. bucephalus* and the American species of *Parabolinoides* occur at about the same horizon.



Family OLENIDAE Burmeister
Subfamily LEPTOPLASTINAE Angelin
Genus SPHAEROPHTHALMUS Angelin 1854

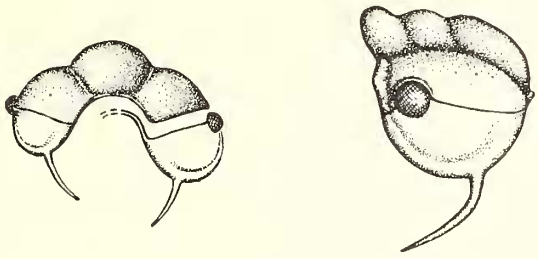
Type species (subsequently designated by Linnarsson 1880). *Trilobites alatus* Boeck, 1838.

According to Henningsmoen (1957, p. 211) there are four species of *Sphaerophthalmus*, all occurring in the Upper Cambrian *Peltura* Zones of the North Atlantic Province. He

lists *S. alatus* (Boeck), *Olenus humilis* Phillips 1848, *S. majusculus* Linnarsson 1880, and *S. major* Lake 1913. Henningsmoen discussed the nomenclature of the species; his conclusions may be summarized as follows:

1. In 1880 Linnarsson stated that *Olenus humilis* Phillips was a junior synonym of *Sphaerophthalmus alatus* (Boeck). Henningsmoen showed that this was a mistake, the species being distinct.

2. Other workers accepted Linnarsson's statement; one such was Lake (1913) who figured and described material from Phillips's type-area for *Olenus humilis* under the name *S. alatus* (Boeck). Henningsmoen suggested that the name *humilis* should be revived for *S. alatus* of Lake (not Boeck). Lake (op. cit.) also described a new species, *S. major*.



TEXT-FIG. 2. Reconstruction of cephalon of *Sphaerophthalmus humilis* (Phillips) showing attitude of free cheek, ×10, anterior and lateral views. Cranidium after Westergård.

3. Westergård (1922) likewise figured Phillips's species under the name *S. alatus* and he tentatively assigned a second species to *S. major* Lake; he also re-illustrated *S. majusculus* Linnarsson. Henningsmoen pointed out that although the Scandinavian specimens of '*S. major*' should be referred to *S. alatus* (Boeck) the same was not necessarily true of the type-material of *S. major*.

The morphology of Sphaerophthalmus. The cranidia of species of *Sphaerophthalmus* are convex so that the differences between specimens preserved in limestone and those in shale are quite important, as can be seen in the figures given by Westergård (1922, pl. 13, figs. 9–35). For example, the transversely arched anterior border, when flattened, becomes an emargination in dorsal view (Westergård 1922, pl. 13, figs. 20 and 23), and the post-ocular cheeks are bent up from their original steeply down-sloping attitude so that the width of the cranidium is increased. When the cranidium is flattened the facial suture describes an elongated S-shape, but when preserved convex the course is, in dorsal view, curved anteriorly and nearly straight behind and, in side view, arched up at the palpebral lobe.

The free cheek of *Sphaerophthalmus* bears a hemispherical eye which projects beyond the general line of the facial suture; it appears that this can only fit under the arched palpebral lobe if the free cheeks slope steeply, as I have attempted to show in text-fig. 2. As the cheek spine is bent down in relation to the general plane of the margin of the free cheek it seems that, in life, these spines curved under the cephalon (text-fig. 2), in which position they would prevent the trilobite from crawling on the sea floor; Henningsmoen (1957, p. 78) has suggested that *Sphaerophthalmus* may have been a strong swimmer.

Sphaerophthalmus major Lake 1913

Text-fig. 3*b*; Plate 78, figs. 1–8

1913 *Sphaerophthalmus major* Lake, p. 77, pl. 8, figs. 7, 9–13; ? *non* fig. 8.
1949 *Sphaerophthalmus major* Lake; Edmonds, p. 60.
1952 *Sphaerophthalmus major* Lake; Hutchinson, p. 90, pl. 4, fig. 17?; *non* fig. 16 [= *Ctenopyge fletcheri* (Matthew)].
1957 *Sphaeroplthalmus major* Lake 1913; Henningsmoen, p. 217.
1957 *Sphaerophthalmus humilis* (Phillips 1848) [*partim*]; Henningsmoen, pl. 22, figs. 7, 11?, 15 only.
1957 *Sphaeroplthalmus minor* [*sic*]; Henningsmoen, p. 218 (error for *S. major*).

Lectotype. As lectotype I select the cranidium GSM 8903 (Pl. 78, fig. 2) illustrated by Lake (1913, pl. 8, fig. 7) which was collected from the White Leaved Oak Shales at White Leaved Oak, Malvern, and presented to the Geological Survey by Miss M. Lowe.

Other material. Apart from BM I 14849 (the original of Lake's pl. 8, fig. 10) which has not been seen, all of Lake's syntypes have been examined and are considered to be conspecific except possibly I 14851 (the original of Lake's pl. 8, fig. 8); this consists of two free cheeks, probably of a *Ctenopyge* species, and a thorax, possibly of *S. major*, upside-down and back-to-front in relation to them. Topotype material in the collections of the Geological Survey Museum, the Sedgwick Museum, the Oxford University Museum, and the British Museum (Natural History) has also been examined.

Diagnosis. A species of *Sphaeroplthalmus* with palpebral lobes which do not project laterally and whose centres are opposite or slightly behind the anterior ends of S1; eye-ridges weak or absent; inter-ocular cheeks more than half as wide as glabella (about two-thirds as wide as glabella in shale-preserved specimens) at eye-line; occipital spine relatively long; free cheek semicircular with long spine springing from the middle of the lateral margin; thorax with axial nodes and pleural spines, pleural regions about two-thirds as wide as the axis; pygidial outline rounded behind, pleural regions about two-thirds as wide as axis which is composed of about three rings.

Description. The general features of the cranidium are very like those of *S. humilis*. Glabella prominent but commonly flattened in shale-preserved specimens, in which cases the axial furrow may be deepened. S1 oblique backwards, concave, joined across glabella in an even curve; S2 very short or indistinct impressions in the sides of the glabella. Occipital spine long but in many specimens only a tubercle is preserved.

EXPLANATION OF PLATE 78

Sphaeroplthalmus species, ×6.

Figs. 1 and 5 are of specimens from the Upper Dolgelly Beds near Dolgelly, Merioneth (Belt Collection); the remainder are from the White Leaved Oak Shales of the Malvern Hills.

Figs. 1–8. *S. major* Lake. 1. Small cranidium showing long occipital spine, BM I 7619 *partim* (see Fig. 5). 2. Lectotype cranidium, GSM 8903. 3. Cranidium showing mould of occipital spine, SM A53115. 4. Cranidium, SM A53088. 5. Cephalon and thorax, paratype, BM I 7619 *partim*. 6, 7. Free cheeks, SM A52564, 52562. 8. Thorax and pygidium, paratype, SM A509.

Figs. 9, 10. *S.* cf. *alatus* (Boeck), external moulds of cranidium and free cheek, SM A53130.

Figs. 11–15. *S. humilis* (Phillips). 11, 12. Cranidia, SM A53093, GSM 8963. 13. Cranidium from Phillips's Collection, Ox A287a. 14. Free cheek, SM A52546. 15. Thorax and pygidium figured by Lake, GSM 8913.

Photographs by Mr. J. M. Pulsford.

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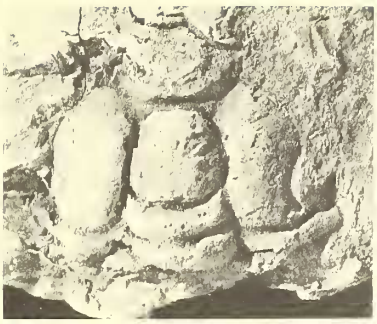

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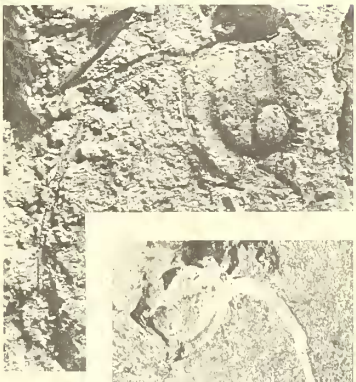

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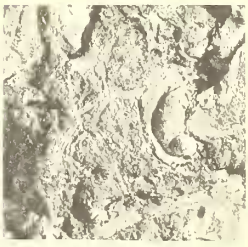

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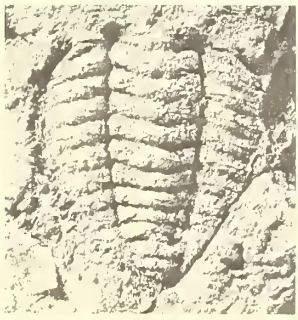

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RUSHTON, Upper Cambrian trilobites